Can we ramp the rotators faster?

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Session 2 – P-P Goals: Luminosity, Polarization
Can we ramp the rotators faster?

- My first response to the question was NO.
- After thinking about it – maybe a little.

- These magnets were not designed to ramp with beam!
- These magnets were not designed to ramp faster then ~ 0.5 to 1.0 Amps per sec. (Up Ramp)

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Why the magnets can't ramp faster.

- Across every coil block there are quench protection resistors. They have a resistance of 0.05 ohms. There are 16 coil blocks per storage unit.
- The inductance of these magnets are very high ~ 4.8 H per storage unit.
- When ramping a voltage is required to change the magnet current

  (V=Ldi/dt) and the voltage causes the temperature of quench protection resistors to increase. (V^2/R=watts) This energy is dissipated in the end region of the magnet.
- The problem is that the temperature of the superconducting cable gets elevated to the point where the cable quenches.
- At 1 Amp/sec and 4.8 H you get 4.8 volts across the magnet, you have 0.8 ohms (16 x 0.05 ohms) across this 4.8 volts and you get an avg. power of 18 watts. This 18 watts has to be dissipated by helium cooling.

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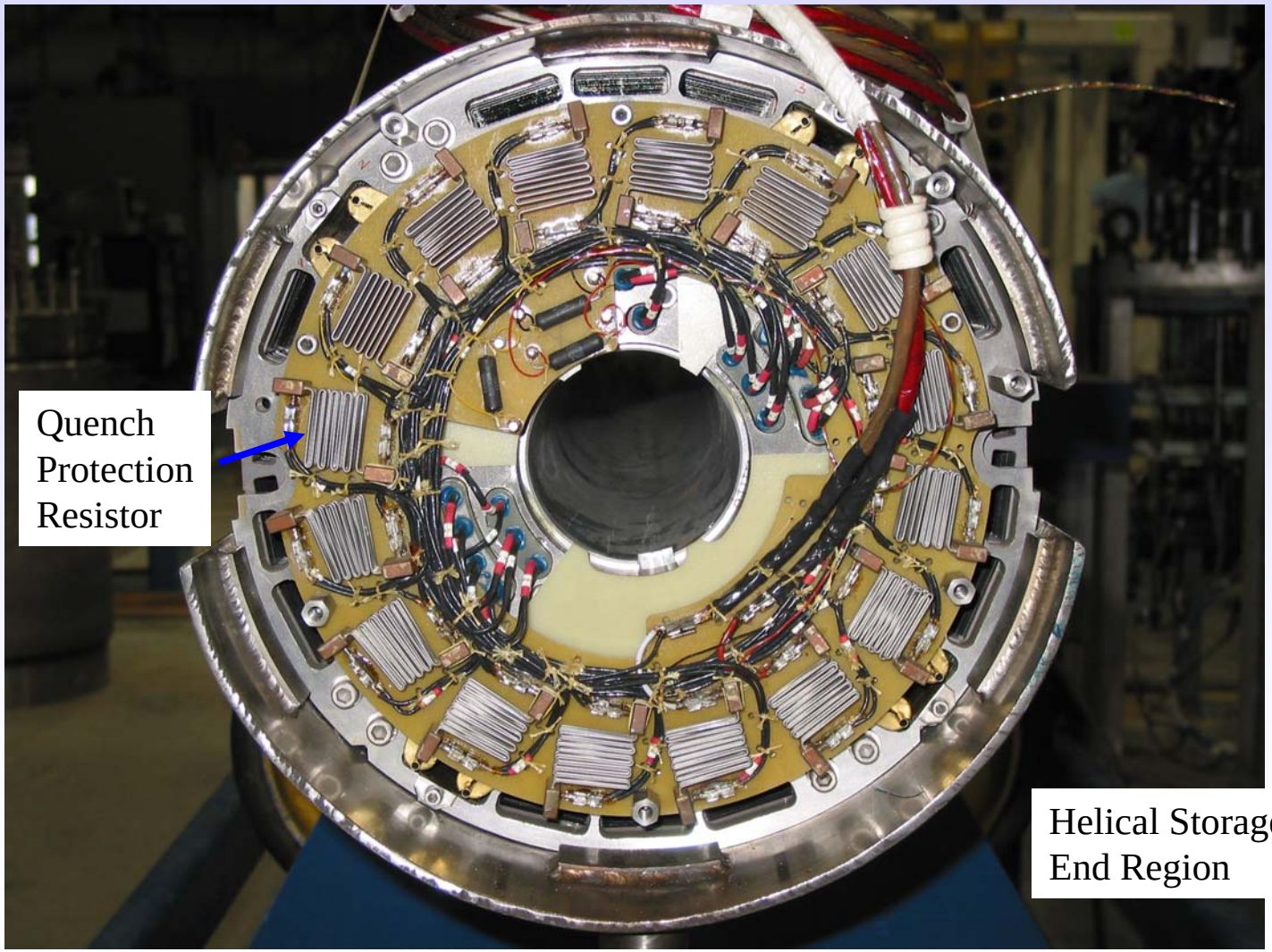

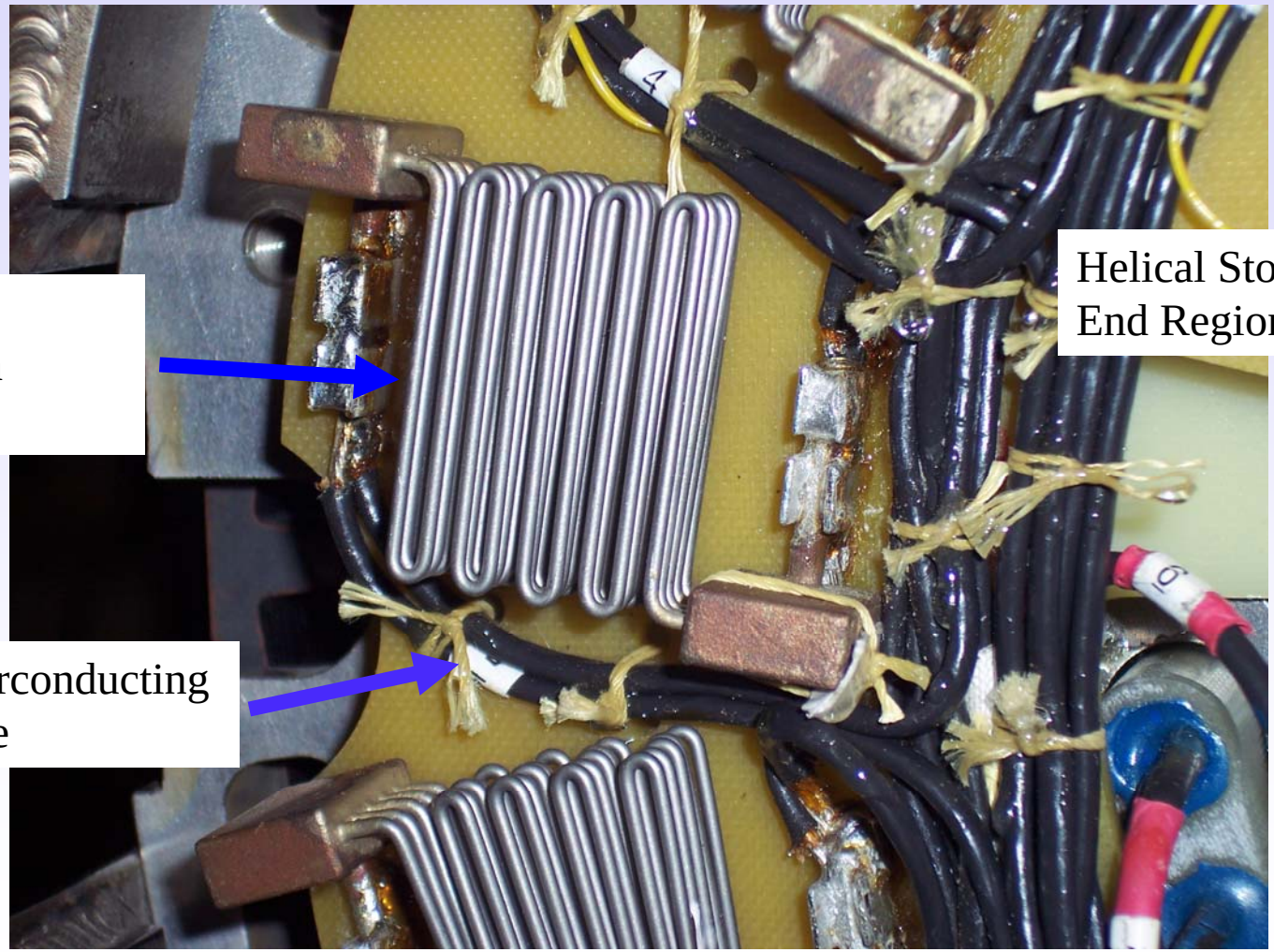
Quench Protection Resistor
Helical Storage Unit End Region
Superconducting Cable

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Why the magnets can't ramp faster

- When testing the magnets in the ring we have seen rotators quench at 0.65 Amps/sec. (some snake magnets quench at lower ramp rates.)
- When ramping a group of rotators the one that requires the lowest ramp rate will determine the rate of the others.
- At higher currents (above 275 Amps) some rotators may require slower ramp rates. (~ 0.5 Amps/sec.)
- The ramp rate we use now is ~ 0.5 Amps/sec. on the up ramp and ~ 0.37 Amps/sec. on the down ramp. (There are rates slower on portions of the down ramp.)
- The down ramp is slower because we are using a uni-polar p.s. and can not supply negative voltage.

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What can be done?

- Try to increase the up ramp rate a little to ~0.55 . This will decrease the time by 10 %. This will have to be tested with all the rotators ramping together.

  (This can be done with the present ramp manager) If a ramp from 1 Amp to 151 Amps takes 300 sec. you would save 30 sec.
- Modify p.s. circuit to enable ~ 0.5 Amp/sec down ramps – possible savings of 100 to 200 sec.
- Start the ramp at a higher current - 25 to 50 amps. This means you would have to learn to inject into RHIC with the rotators at this current.

  If a ramp from 50 Amps to 150 Amps takes 200 sec. you would save 100 sec. from a ramp that started at 1 Amp. (You will save more on the down ramp.)
- Remove all the rotators, disassemble the magnet to the storage units, remove the quench protection resistors and replace them with cold diodes. (This will require a lot of resources and time !)

Recommendations

- Try to ramp the magnets a little faster – Testing this will be easier with the ramp manager. A good estimate of the max. rotator currents will be needed.
- Learn to inject into RHIC at a higher current in the rotators.
- Do an engineering study on what p.s. modifications would be needed for fasted down ramps.
- Learn to inject into RHIC with the rotators at their operating currents?